JOURNAL OF SCIENTIFIC INSTRUMENTS

VOL. IX MARCH, 1932 NO. 3

DESCRIPTIONS OF THE EXHIBITS AT THE TWENTY-SECOND ANNUAL EXHIBITION OF THE PHYSICAL AND OPTICAL SOCIETIES: (*continued*)

RADIO AND ALLIED INSTRUMENTS AND APPARATUS.

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RADIO apparatus was not a very conspicuous feature of this year's exhibition. A number of standard pieces of apparatus both of the laboratory and commercial nature were shown, but it is proposed to confine this article to a description of the more interesting novel exhibits which were noticed in a tour of the exhibition.

General Radio Apparatus

Among the exhibits of the NATIONAL PHYSICAL LABORATORY, Mr F. M. Colebrook showed items of apparatus which form part of a complete equipment for conducting comprehensive performance tests on radio receivers. One of these comprised a meter for measuring the depth of modulation of a radio-frequency carrier wave by the aid of two rectifying valves in the manner described by K. W. Jarvis*. The direct current output of the first valve is set at a predetermined value and the audio-frequency output is then measured by the second valve acting as a rectifying valve-voltmeter. Care is taken that the set is operating within the limits of the square law characteristics of the valves, and the modulation is then simply obtained from the direct current meter readings with the aid of a previous calibration. In connexion with this and other measurements a two-stage valve-voltmeter was shown, the sensitivity of which was such as to give full scale deflection for an input of about 60 millivolts. The first valve was a rectifier of the usual pattern, while the second acted as a simple direct-current amplifier.

The third piece of apparatus shown on this stand consisted of a bridge arrangement for the measurement of the total harmonic content of an audio-frequency alternating current supply. The bridge operates on a principle which was described by I. Wolff†. One arm of the bridge includes a series resonance circuit which can be tuned to the fundamental frequency and the bridge can then be balanced for this frequency only. In this condition the output or detector circuit voltage will be a measure of the total harmonic content of the input voltage wave. If the tuned arm is now open circuited the output voltage will be a measure of the total input voltage. Thus by varying the input voltage in such a way that the output is the same in root-mean-square values for the above two cases, a measure is obtained of the ratio of the harmonic content to the total wave.

* K. W. Jarvis. *Proc. Inst. Rad. Eng.* **17** 1929 (664).

† I. Wolff. *Journ. Opt. Soc. Amer.* and *Rev. Sci. Instr.* **15** 1927 (163).

Some of the exhibits shown by the ELECTRIC & MUSICAL INDUSTRIES, LTD., were similar to those described above. For example, a direct-reading modulation meter working on the same principle as that already described was shown, an account of this instrument having previously been published in the *Wireless Engineer**. The output from this meter was arranged after amplification to operate a Duddell oscillograph, so that photographic records could be obtained of the variation in modulation percentage on typical broadcast transmissions. A few such records exhibited showed that for ordinary speech the modulation is of the order of 10–20 per cent. of the carrier wave, whereas the value may rise to over 80 per cent. during musical portions of the programme.

For the purpose of analysing the harmonic content of an audio-frequency wave, this firm has developed an apparatus operating upon somewhat different lines from that described above. The oscillations under analysis are mixed with those from a beat frequency oscillator to produce low frequency beats of the order of 20 cycles per second which are detected by the aid of a vibration galvanometer. By tuning the frequency of the local oscillator in turn to the frequencies corresponding to the fundamental and the successive harmonics, the amplitude of vibration of the galvanometer provides a measure of the amplitude of each of the harmonics present in the supply.

Thermionic Valves

A great variety of modern receiving valves were shown on the stands of the MARCONI OSRAM VALVE CO., LTD., and of the MULLARD WIRELESS SERVICE CO., LTD. Of particular interest is the new type of valve with a variable magnification factor which has recently come into prominence as a means of providing automatic grid bias in the early stages of a wireless receiver, so as to avoid overloading of the receiver when this is operated upon signals over a wide range of intensity. This type of valve is provided with a grid, the spacing of which is not uniform along its length, the result being that the magnification factor varies according to the actual part of the characteristic at which the valve is operated.

An interesting additional application of this type of valve was shown by the ELECTRIC & MUSICAL INDUSTRIES, LTD., in the form of an attenuator which incorporated this valve in one stage of an amplifier. The gain in decibels may be made directly proportional to the grid bias up to a maximum amplification of about 60 decibels. By combining the arrangement with an exponential grid voltmeter a direct-reading volume indicator is obtained covering a magnification ratio of about 100 decibels. A further exhibit of this firm was an assembly of apparatus for measuring the magnification and mutual conductance factors of receiving valves with alternating current of a frequency of 50 cycles per second. The instrument has previously been described by C. S. Bull†.

In connexion with measurements on valves, the late Dr D. W. DYE, of the National Physical Laboratory, showed apparatus by which the very small capacity between grid and anode of screen grid valves may be measured accurately. The method consists in measuring first at a radio frequency the change in input capacity of the valve when a large impedance in the anode circuit is short-circuited. The magnification of the stage comprising valve plus impedance is next measured at an audio-frequency when the grid anode capacity is obtainable by a simple calculation. Owing to the high magnification factor of this type of valve, considerable accuracy is obtainable in the measurement of the very small capacity involved.

A number of new types of medium power transmitting valves were shown by the two valve manufacturers already referred to, but the most prominent exhibit in this direction was that of a 500 kW self-contained transmitting valve (Fig. 1) which had just been completed

* *Wireless Engineer*, 8 1931 (647).

† C. S. Bull. *Experimental Wireless*, 8 1931 (70).

by the GENERAL ELECTRIC COMPANY; it has been completely exhausted and sealed off, and requires no further attention during its life, which is estimated at 10,000 hours. The valve is a development of the previous CAT type of valve which had an input power rating of 50 kW. Several valves of this type are in operation at the Rugby station and also at various European broadcasting stations. The latest product is capable of an output of 375 kW when used for telegraphic signalling purposes, and when used as an amplifier in radio-telephony it will handle an output of 85 kW at 90 per cent. modulation. This new valve, which is of the cooled anode type, has a glass envelope in the upper half and the usual copper-glass seal; it carries a filament current of 460 amperes at 32·5 volts and the electron emission attains a value of 100 amperes, the magnification factor being 45.

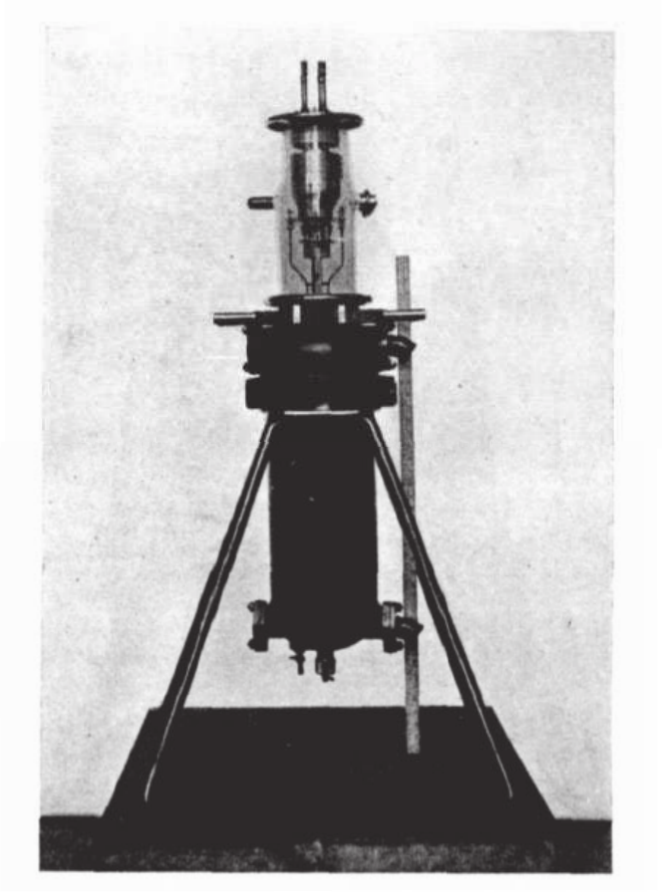

Fig. 1

A new form of rectifying valve of the high power type CAR 5X was shown. This valve consumes a filament current of 100 amperes at 20 volts, and the anode circuit impedance is 100 ohms at applied voltages up to 12,000.

At the other end of the scale it is interesting to note that some small split anode valves were exhibited by the GENERAL ELECTRIC CO.'S Research Laboratories for use on very short wave-lengths. These valves are intended for operation in the well-known magnetron type of circuit and will operate on various wave-lengths down to about 30 cm., at which it is claimed that an output of about half-a-watt may be obtained.

While on the subject of thermionic valves mention may be made of the associated items of apparatus—the photoelectric cell and the thyratron—which are now finding such wide application to a large number of electrical engineering problems. The fundamental properties of the thyratron, which is a hot-cathode gas-filled rectifier, were admirably demonstrated by a series of experiments shown on the stand of the BRITISH THOMSON-HOUSTON CO., LTD.

Miscellaneous Laboratory Apparatus

Turning now to measuring apparatus, the application of which is more or less confined to the wireless laboratory, a new type of Moullin voltmeter was exhibited by the CAMBRIDGE INSTRUMENT CO., LTD. This instrument incorporates three valves, the functions of which are high-frequency amplifier, rectifier, and balancing valve respectively. The instrument is claimed to be independent of frequency up to 500 kilocycles per second on its most sensitive range, which gives full scale deflection for 30 millivolts input, and the model was provided with multipliers extending the range up to 1·5 volts R.M.S.

Messrs H. TINSLEY & Co. also showed a radio-frequency ammeter which operates upon a novel principle due to Dr Barlow. The filament of a two-electrode valve is heated by direct current and the anode potential is adjusted so that the valve is saturated. When alternating current is passed through the filament the emission increases corresponding to the rise in temperature of the filament, and the indicating instrument in the anode circuit measures the

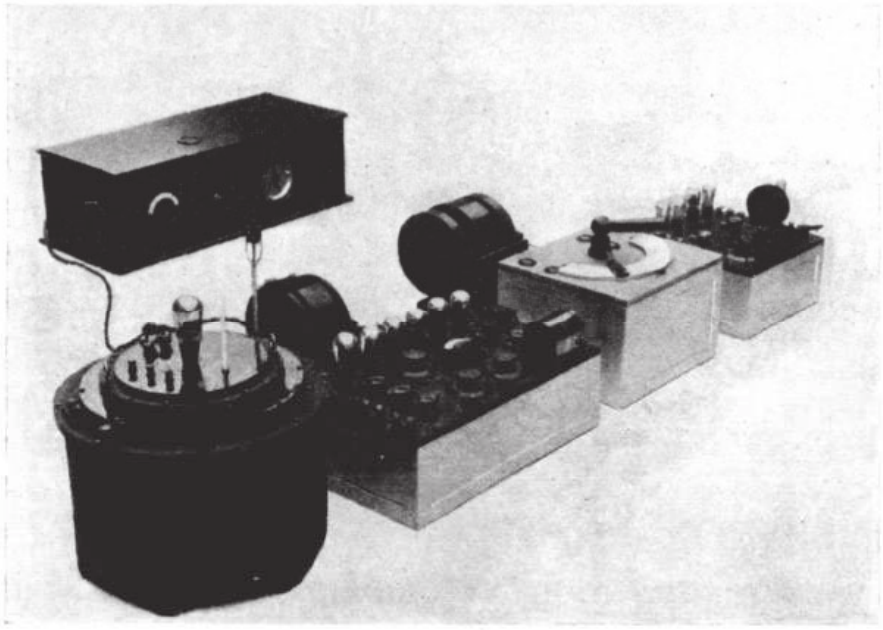

Fig. 2

increase in emission caused by the alternating current. It is claimed that the instrument is suitable for accurate measurement purposes over a range of frequencies of from twenty-five to six million cycles per second.

These two instruments were the only novelties in this direction found at the exhibition, although there was, of course, the usual display of both direct-current and alternating-current instruments for use in wireless research work exhibited by the manufacturers specializing in this type of instrument.

Messrs H. W. SULLIVAN, LTD., had their usual very attractive display of apparatus for high precision measurement work at both audio and radio frequencies. Among the new instruments exhibited was a temperature-controlled valve-maintained tuning fork which is intended for use as an absolute standard of frequency. This is shown in Fig. 2 complete with multivibrator equipment and synchronously driven clock. The fork is mounted with its valve maintaining circuit in a double chamber, in the outer of which is fitted a heating element which is controlled by a regulator of the toluene-mercury type. By this arrangement temperature control of the inner chamber is obtained to closer than 1/10° C. The fork is adjusted initially to within one part in 10^5 of the nominal value and the temperature

coefficient of the frequency is of the same order. The fork may be used to drive a clock with the aid of a synchronous motor so that harmonic radio-frequencies may be compared with the tuning fork standard over relatively long periods of time.

A somewhat similar set up of tuning fork apparatus to act as a frequency standard was exhibited by Messrs MUIRHEAD & CO., LTD., and in each case the arrangement of the standard fork is due to the late Dr D. W. DYE of the National Physical Laboratory.

As a somewhat less expensive form of standard wavemeter than the fork-controlled multivibrator, Messrs H. W. SULLIVAN, LTD. have developed a quartz-controlled multivibrator wavemeter which has a wave-length range of from 100–6000 metres. The fundamental frequency of the quartz crystal standard is 50 kilocycles per second, and harmonics from 50–3000 kilocycles per second were obtained from this standard generator, while another controlled frequency of 1000 cycles per second produces a series of synchronizing beat effects which facilitate exact interpolation between these harmonic frequencies. This controlled low frequency multivibrator is also used to drive a clock synchronously through an amplifier, thus providing for direct observation of the exact frequency of the wavemeter to an accuracy of one part in a million.

Among the useful laboratory apparatus of a precision, but not necessarily of a standard, nature exhibited by Messrs H. W. SULLIVAN, LTD. was a capacity test set covering a range of from 2 or 3 up to 1000 micro-microfarads, and of both fixed and variable air condensers having a very high permanence of value and freedom from the power losses of temperature coefficient. This apparatus should be found very useful in alternating-current measuring laboratories where the increased cost of the higher grade standard apparatus is not justified.

As an auxiliary item in a radio laboratory, it was noticeable that the cathode ray oscillograph is developing into a more useful and more robust piece of apparatus, and samples of the modern types were shown on the stands of the EDISON SWAN ELECTRIC CO., LTD., and and Messrs W. EDWARDS & CO., LTD.

A further small but by no means negligible item to which attention may be drawn is the very fine nickel chromium resistance wire which was exhibited by Messrs F. J. WITTS & CO. and by the BRITISH ELECTRIC RESISTANCE CO., LTD. This wire can be supplied in diameters down to about 1/1000th in. and when wound on an asbestos core of about 1/16 in. diameter, resistance values up to one million ohms per yard can be obtained. This wire should find a very useful application for the construction of non-reactive resistance units for high frequency measurement purposes.